E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 76.37
(GIF) Impact Factor: 0.549
IJFAS 2025; 13(5): 225-229

www.fisheriesjournal.com
Received: 13-07-2025
Accepted: 17-08-2025

Rituraj Dutta
Fish Breeding Training Centre, Nipokunja, Rabindrapally, Panchpota, Kolkata, India

Sobhini Nandy
Fish Breeding Training Centre, Nipokunja, Rabindrapally, Panchpota, Kolkata, India

BK Mahapatra
Former Principal Scientist, ICAR-CIFE, Salt Lake, Kolkata, West Bengal, India

Corresponding Author:
Rituraj Dutta
Fish Breeding Training Centre, Nipokunja, Rabindrapally, Panchpota, Kolkata, India

Length-weight relationship and relative condition factor of Bombay duck (*Harpadon nehereus*, Hamilton, 1822) from the north-east coast of India

Rituraj Dutta, Sobhini Nandy and BK Mahapatra

DOI: https://www.doi.org/10.22271/fish.2025.v13.i5c.3164

Abstract
Harpadon nehereus (Hamilton, 1822), commonly known as Bombay ducks, were collected from the North-East Coast of India for 1-year period (2024-2025) to analyse their Length-Weight (L-W) relationship and the Relative Condition factors (Kn). A total of 217 specimens, 169 males and 48 females, were used for this study. The result showed isometric growth for both males, females, and for combined at a significant level of 5% (p>0.05). Therefore, it maintains the Cube's Law. The linear regression model of L-W Relationship for combined [LogW=2.966332LogTL-2.35996, R^2=0.725, r=0.852], for male [LogW=3.204787LogTL-2.65817, R^2=0.768, r=0.876], for female [LogW=2.926169LogTL-2.33932, R^2=0.644, r=0.802]. Relative Condition Factors (Kn) were also calculated, for combined Kn=1.110474± 1.129, for male Kn=1.11472±1.129, for female Kn=1.176585±1.214, indicating that the specimens belong to a moderate environmental condition, as all the Kn=1 (p>0.05). Sex ratio was obtained, Female/Male=0.284, (p<0.05); which was not equal to one. The total length range (17.7 - 19.3 cm) was predominantly observed among the analysed specimens.

Keywords: *Harpadon nehereus*, Length-Weight Relationship, Condition factors, North-East Coast

1. Introduction
Bombay duck, the common name of *Harpadon nehereus* (Hamilton, 1822), comes under the order: Anulopiformes, Family: Synodontidae, and is mostly present in the brackish and marine waters and is present in benthopelagic regions [1]. In Maharashtra, Bombay duck locally, known as "bombil" and in Gujarat "Bumla", *H. nehereus* is mostly found from the northern Exclusive Economic Zone (EEZ) of India, i.e., in the North west coasts of Maharashtra and Gujarat and the North East coast of West Bengal [2]. Based on the report of CMFRI (1980) [3]. 98% of the Bombay duck capturing is done from the West Coast, majorly in Maharashtra and Gujarat [3]. West Bengal and Orissa together show only 1.18% of the total landings of Bombay duck [3]. The resent report showed that out of 1980 thousand tonnes of pelagic resources, 1.54% of Bombay duck was contributed from Gujarat and only 0.72% from West Bengal [4]. Most articles on length-weight relationship and condition factors on Bombay duck are found from the West coast of India. Here, a study of the length-weight relation and relative condition factor of Bombay duck is presented on the North-East Coast of India.

2. Materials and Methods
Samples were randomly collected for a year period from August 2024 to July 2025, from different commercial landing centres of the North-East Coast of India (Kakdwip, Namkhana, Mohana, Shankarpur and Fraserganj). A total of 217 specimens were collected and the L-W relationship was examined by taking their weight (W) in grams on an electronic balancer and measuring it's total length (TL) in Image J software in centimetres. The L-W relationship was measured by the equation $W=aL^b$, where W is weight in grams (g), L is total length (TL) in centimetres (cm), a is the intercept or regression constant and b is the slope or regression coefficient [5, 6, 7, 8]. The above mentioned equation is linearized to LogW = bLogL + Loga [5, 6, 7, 8] and computed in Microsoft Excel to determine "a" and "b" values of male group, female group and combined.

Relative condition factor (Kn) was calculated for each male, each female and for all specimens by using their respective L (TL) in cm, W in g, "a" and "b" value; [Kn=W/(aL^b)] [5, 7, 8]. Then the mean "Kn" ± Standard deviation (SD) was calculated for males, females and overall specimens.

The fitness of the L-W relationship model for males, females and combined were estimated by R^2 (coefficient of determination) and the relation between TL and W was estimated with Pearson's correlation coefficient (r). Sex ratio was also determined by dissecting each specimen to verify male or female by observing the gonads.

3. Result and Discussion

3.1. Sex ratio

169 males (M) and 48 females (F) were identified from 217 specimens by dissecting and observing each *H. nehereus*, sex cannot be distinguished from external characters; therefore, observing the gonads helps to separate males and females [9, 10]. Chi-square test was done along with the test of significance of 5%, as done by other research workers [9, 10, 11]. The sex ratio of F/M=0.284, which deviated significantly from the expected sex ratio of 1 (p<0.05).

3.2. Length-Weight relationship

The L-W relationship of the studied specimens showed a linear relation on natural logarithmic transformation. The calculated coefficient of determination (R^2) value showed how fit is the regression model with the plotted logarithmic data points of (TL) and (W) and Pearson's correlation coefficient (r) showed the degree of correlation between (TL) and (W) [12].

The calculated 'R^2' for males is 0.768, for females is 0.644 and for combined is 0.725 (Table 1). Generally, an 'R^2' value above 0.5 is considered a good fit for regression modelling [12]. Here, the measured 'R^2' for males, females and combined is greater than 0.5, so it is a good fit.

The calculated 'r' for males is 0.876, for females is 0.802 and for combined is 0.852 (Table 1). The r-value greater than 0.0 is considered as positively correlated and less than 0.0 is negatively correlated [12]. If the absolute r-value is near 1.0, it shows a strong correlation [12]. Therefore, the calculated 'r' for males, females and combined is positively directed with a strong correlation.

The regression equation for males is LogW=3.204787LogTL-2.65817, for females is LogW=2.926169LogTL-2.33932 and for combined is LogW=2.966332LogTL-2.35996 (Table 2). The 'b' value or slope for males, females and combined is 3.204, 2.926 and 2.966 respectively (Table 2). The b>3 represents a positive allometric growth, b<3 represents a negative allometric growth and b=3 represents isometric growth [5, 6, 7, 8]. The 'b' value of each group was tested against the theoretical 'b' value 3 based on Cube's Law, along with the significance of 5%, as done in other research workers [5, 7, 8], and it is observed that both the sexes and combined are showing isometric growth (all the body parts are growing equally), i.e., 'b'= 3, (p>0.05). Therefore, it is follows Cube's Law. Here, the Cube's Law shows weight (W) proportional to (L^b), where b is three [5].

Other research on Bombay duck showed allometric growth, such as (b=3.265) from Bay of Bengal [13]; (b=3.444) and (b= 3.717) for female and male H. nehereus respectively, from Arabian Sea [9]; (b=2.028) from North-West Coast [14]; (b=2.218) from Chittagong [15]. Again, some also showed isometric growth, such as (b=3.051) from Bay of Bengal [16]; (b=2.889) from Arabian Sea [17]; (b=2.96) from Bay of Bengal [18].

Another research from the North-West Coast of India showed b=3.03 for males (isometric growth) and b=3.10 (allometric growth) for females with 1523 specimens [19].

Relative condition factor (Kn) for male is Kn=1.11472±1.129, for female is Kn=1.176585±1.214, for combined is Kn=1.110474±1.129 (Table 2). If Kn≥1, the growth condition is good and if Kn<1, the growth condition is bad [7, 8]. The Kn for both sexes and combined is equal to 1.0 (p>0.05), so the specimens belong to a good environmental condition for their growth.

Kn=1.03 from the Bay of Bengal [16]; Kn=0.978, 1.033, and 1.097 observed for 3 months from Chittagong [15]; Kn=1.02 ± 0.21 from the West Coast of India [19] is reported in different research, which is nearly equal to one.

Table 1: Regression Statistics.

Sex	Observations	Multiple R	R^2	Adjusted R^2	r	Std. Error
Male	169	0.876442746	0.768152	0.766763575	0.876	0.06881908
Female	48	0.802602847	0.644171	0.636435925	0.802	0.102216093
Combined	217	0.851741154	0.725463	0.724186077	0.852	0.079290779

Table 2: L-W relationship equation and mean relative condition factor (Kn) of *H. Nehereus.*

Sex	Regression Equation	"b" value	Growth	Mean "Kn"± SD
Male	Log W = 3.204787 Log TL - 2.65817	3.204	Isometric	1.11472± 1.129
Female	Log W = 2.926169 Log TL - 2.33932	2.926	Isometric	1.176585± 1.214
Combined	Log W = 2.966332 Log TL - 2.35996	2.966	Isometric	1.110474± 1.129

The graphical representation of regression models for the L-W Relationship of *H. nehereus* (males group, female group and combined) as predicted from the collected data samples from North East coast of India is given in the Figures 1-3.

3.3. Length-frequency distribution

It was observed from the collected specimens that there were variations in lengths. Therefore, a continuous class interval of 1.6 cm distribution table of Total Length (TL) is presented. The distribution tables interpreted that the TL class (17.7 - 19.3 cm) is predominant, followed by the TL class (19.3 - 20.9 cm) in the collected population sample, given in Table 3 and graphically presented in Figure 5-6.

Table 3: Length-frequency distribution of different total length (TL) classes of *H. Nehereus.*

Class. TL (cm)	Freq. TL	Relative Freq. TL	% Freq. TL
14.5 - 16.1	3	0.013824885	1.3824885
16.1 - 17.7	21	0.096774194	9.6774194
17.7 - 19.3	68	0.313364055	31.336406
19.3 - 20.9	60	0.276497696	27.64977
20.9 - 22.5	35	0.161290323	16.129032
22.5 - 24.1	27	0.124423963	12.442396
24.1 - 25.7	3	0.013824885	1.3824885
Total	217	1	100.00%

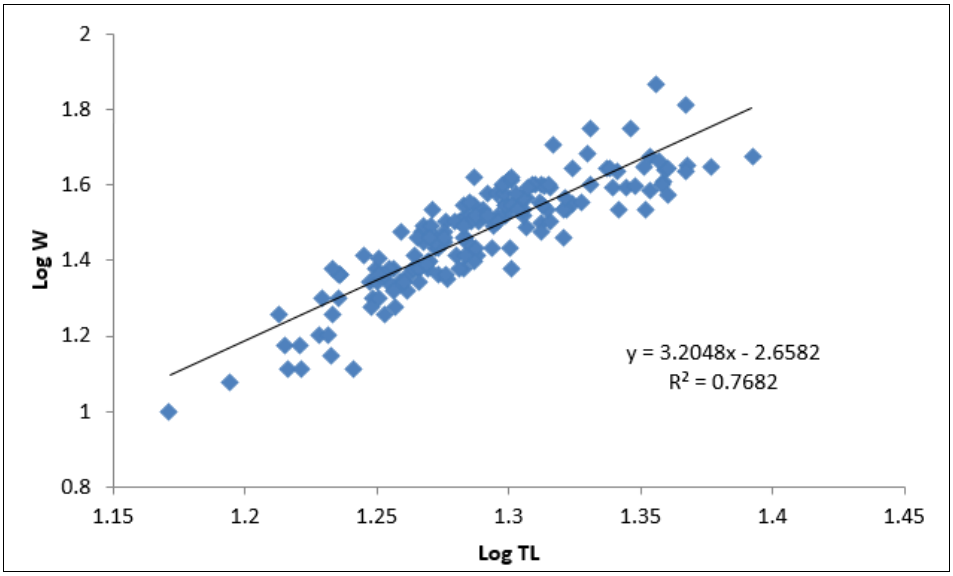

Fig 1: L-W relationship between Log TL and Log W in *H. nehereus* (Male).

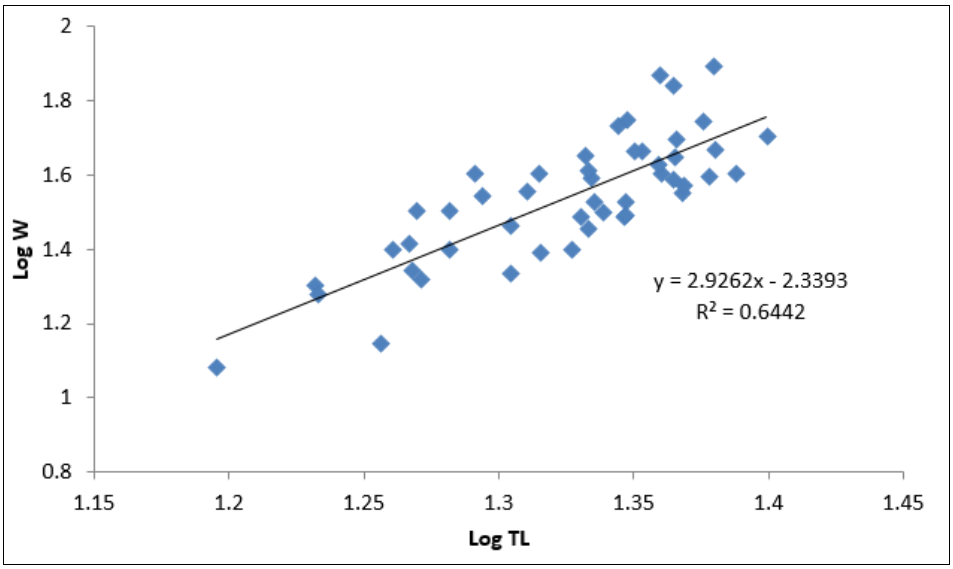

Fig 2: L-W relationship between Log TL and Log W in *H. nehereus* (Female).

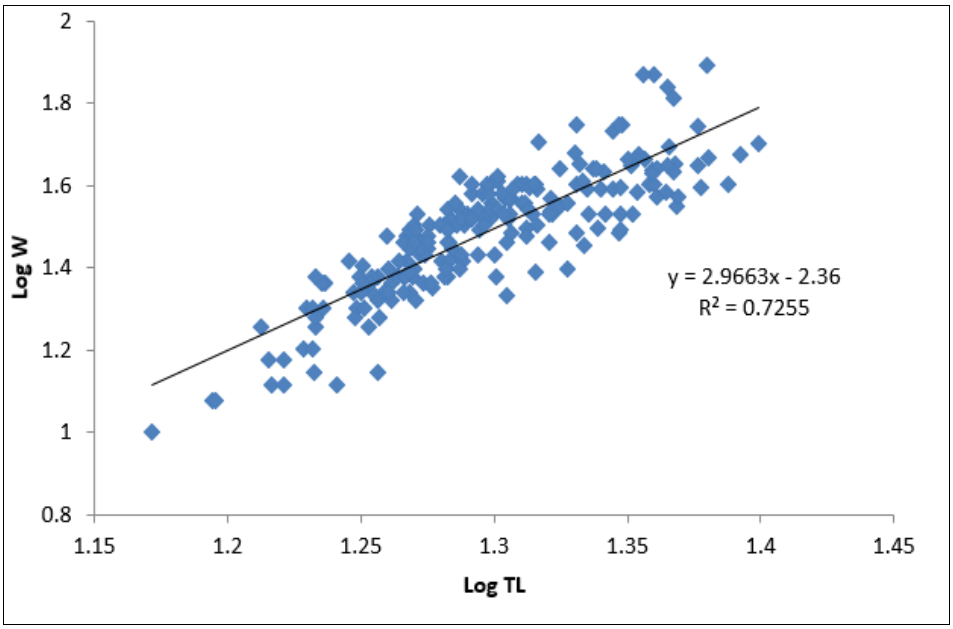

Fig 3: L-W relationship between Log TL and Log W in *H. nehereus* (Combined).

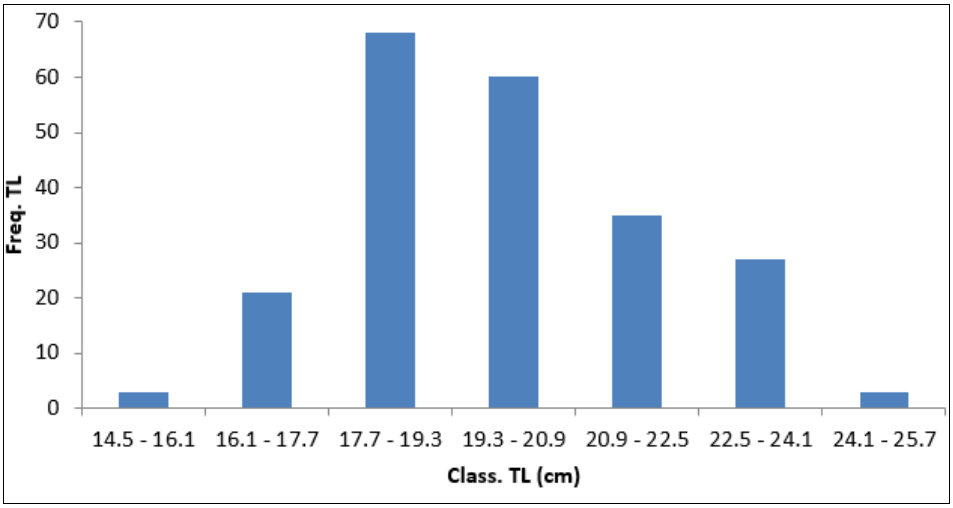

Fig 5: Length-frequency distribution of different total length (TL) classes of *H. Nehereus.*

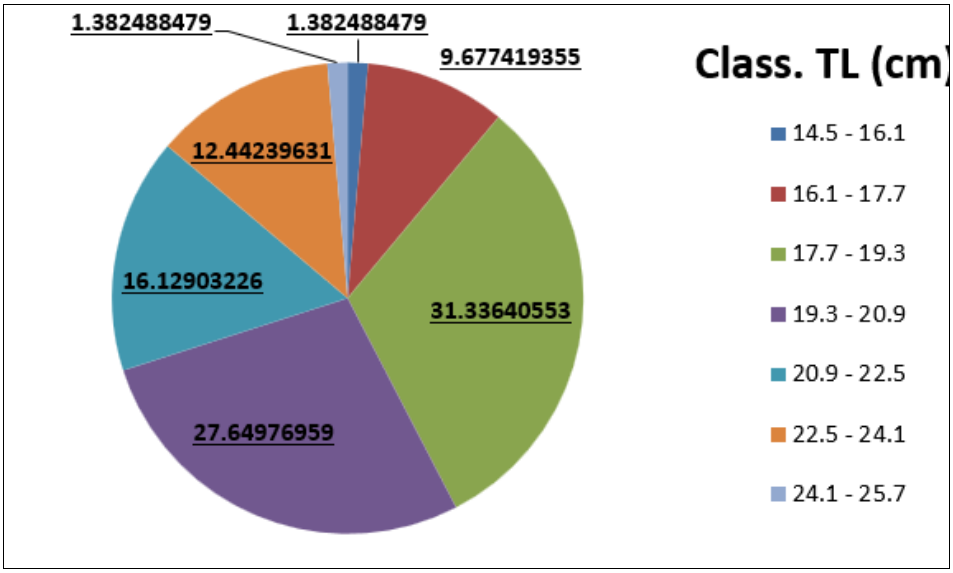

Fig 6: Length-frequency distribution of different total length (TL) classes of *H. Nehereus.*

4. Conclusion

The sample population from the North-East Coast of India showed that the male groups, female groups and the combined are growing isometrically based on the regressing calculation, i.e., the growth pattern suggesting that it is maintaining the Cube's Law, where b=3. The sex ratio of the female group to the male group is 0.284, which indicates that the sex ratio is significantly different from the hypothesized sex ratio =1, with a significance level of 5%. The length group of (17.7-19.3) is dominating over the year, followed by the length group of (19.3-20.9).

5. References

1. www.fishbase.org. 2025. [cited 2025 Apr]
2. Anulekshmi C, Nakhawa AD, Azeez PA, Akhilesh KV, Bhendekar S, Khandagle PA, *et al.* Biology of the Bombay duck *Harpadon nehereus* (Hamilton, 1822) from the north-eastern Arabian Sea, India. Indian J Fish. 2024;71(1):70-81. doi:10.21077/ijf.2024.71.1.131151-09
3. CMFRI report. Central Marine Fisheries Research Institute Cochin. 1980.
4. CMFRI report. Central Marine Fisheries Research Institute Cochin. 2020.
5. Le Cren ED. The Length-Weight Relationship and Seasonal Cycle in Gonad Weight and Condition in the Perch (*Perca fluviatilis*). Journal of Animal Ecology. 1951;20(2):201-219. https://doi.org/10.2307/1540
6. Mahapatra BK, Pradhan A, Lakra WS. Morphometrics, Length-Weight Relationship and Condition Factor of *Coilia dussumieri* Valenciennes, 1848 from North-East Coast of India. International Journal of Fisheries and Aquatic Studies. 2015;3(2):35-39.
7. Nazek Jisr, Younes G, Sukhn C, El-Dakdouki MH. Length-weight relationships and relative condition factor of fish inhabiting the marine area of the Eastern Mediterranean city, Tripoli-Lebanon. Egyptian Journal of Aquatic Research. 2018;44(4):299-305. https://doi.org/10.1016/j.ejar.2018.11.004
8. Pathak AK, Kantharajan G, Dayal R, Kumar R, Saini VP, Mohindra V, *et al.* Length-weight relationships and relative condition factor of fish species dwelling in the inland saline river Luni, India, with a note on the associated risks and encounters obstructing the fish diversity and ecosystem services. Indian J Fish. 2022;69(4):59-64. DOI: 10.21077/ijf2022.69.4
9. Bapat SV. The Bombay duck, *Harpadon nehereus* (Ham.). Bulletin of Central Marine Fish Research Institute. 1970;21:1-66.
10. Thu M, Hein ZM, Aung LM. Reproductive Biology Of Bombay Duck, (*Harpadon Nehereus*) In Mon Coastal

Water. J Myanmar Acad Arts Sci. 2021;XIX(4B):XIX(4B). (Note: Page number repeated as issue/article number was the only range provided).
11. Liao Y, Luo S, Liu K. Reproductive biology of the bombay-duck *harpadon microchir* in the coastal waters off south western Taiwan. Journal of Marine Science and Technology. 2014;22(5):22(5). DOI: 10.6119/JMST-013-1211-1 (Note: Page number repeated as issue/article number was the only range provided).
12. Gupta SC, Kapoor VK. FUNDAMENTALS OF MATHAMETICAL STATISTICS (9th ed.). SULTAN & SONS. 1994.
13. Krishnayya CH. Age and growth of *Harpadon nehereus* (Ham.) and its fishery in the Hooghly. Journal of Zoological Society of India. 1968;20:129-147.
14. Kurian A, Kurup KN. Stock assessment of Bombay duck *Harpadon nehereus* (Ham.) off Mahasashtra coast. Indian Journal of Fisheries. 1992;39:243-248.
15. Hasin T. Length-weight relationship and condition factor of bombay duck *Harpadon nehereus* From Landings of Fishery Ghat, Chittagong. Agric Livest Fish Research Article. 2016;3:355-360.
16. Nurul Amin SM. Study on age and growth VPA analysis and relative condition factor of *Horpadon nehereus* (Ham.) from the neretie water of Bangladesh. Online Journal of Biological Science. 2021;1:192-194.
17. Bapat SV, Banerji SK, Bal DV. Observation on the biology of *Harpadon nehereus* (Ham.). Journal of Zoological Society India. 1951;3:441-356. (Note: The page range is formatted as provided, though the sequence appears unusual).
18. Ilah Nur-E-Farjana, Molla S, Khatun S, Laboni TA, Rahman MM, Abedin J, *et al*. Exploring the biological aspects of *Harpodon nehereus* in the Bay of Bengal, Bangladesh: Suggestions for catchable Size. Aquatic Resource Science. 2014;1:36-47.
19. Mahendra F, Prathibha R. Seasonal variations in the length-weight relationship and relative condition factor of Bombay duck, *Harpadon nehereus* (Hamilton, 1822) (Aulopiformes : Synodontidae) inhabiting the marine area of the west coast of India. Indian Journal of Geo-Marine Sciences. 2020;49(11):1758-1763.